Application of a γ-Attenuation Technique for the Study of Phase Separation in Binary Liquid Systems

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The γ-attenuation technique based on the measuring of an attenuation coefficient of a narrow beam of γ-quanta in the sample is a promising method for the study of the processes of phase separation and homogenization in multicomponent melts at high temperatures. A variant of the γ-method developed by us enables one to measure the composition profiles in the liquid samples. For binary systems undergoing two-melt phase separation the method makes it possible to determine the shape of liquid-liquid coexistence curve with a high degree of accuracy. Using this method, experiments were conducted to determine the shapes of two-melt phase boundaries of a number of liquid binary metallic systems with miscibility gap. New data on the two-melt phase boundary of the lead – gallium system are presented. According to the authors' measurements the coordinates of the critical point of the liquid – liquid coexistence curve are $T_C = 879.3 \pm 1.5$ K, $X_C = 41.9 \pm 1.0$ at. % Pb. The obtained results allowed us to refine substantially the X - T diagrams of these alloys over the region of liquid-liquid equilibrium. The critical exponents β of the coexistence curves of the investigated systems lie in the range 0.3 – 0.35 (with an error of 0.005…0.02), that is they are close to the non-classical value of β. For the Pb-Cu and Pb-Ga systems it has been found that near the critical point the temperature dependence of $(X_1 + X_2)/2$ (X_1, X_2) are the concentrations of the phases in equilibrium with each other) exhibits a departure from the law of the rectilinear diameter. In addition to the investigations of X-T diagrams of liquid systems with a miscibility gap, the γ-method allows one to obtain valuable information on the kinetics of dissolving and segregation processes in the multicomponent melts. Experimental data on the rate of homogenization in two-component melts are also presented in the report.